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**Short Communication**

# Development of Avocado oil Nanoemulsion Hydrogel using Sucrose Ester Stearate

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**ABSTRACT**

Nanoemulsion is submicron sized emulsion typically in the range of 20-200 nm. Avocado oil is often used in herbal skin care. The aim of this study was to characterize nanoemulsion hydrogel prepared using avocado oil and sucrose ester stearate as surfactant. The nanoemulsion hydrogel were prepared by nanophase emulsification technique. These formulations were examined using zetasizer to determined the mean diameter of dispersed oil droplets, polydispersibility index (PDI) and zeta potential. Moreover viscosity of the prepared nanoemulsion hydrogel were studied. The results reveled that nanoemulsion prepared with 60% w/w oil, 24% w/w glycerol and 16% w/w surfactant showed droplets size below 200 nm with good polydispersibility index and zeta potential < -30 mV. The optimum formulation of nanoemulsion was prepared in the form of nanoemulsion hydrogel using carbopols 934 and 940. The results of the viscometer for the nanoemulsion hydrogel showed that the storage modulus (G') which describes the elasticity of the component were greater than the loss modulus (G") values which reveals the viscosity of the component.

## INTRODUCTION

In pharmaceutical view, emulsion is one of the major dosage forms in delivering active ingredients to the target area. Emulsion is being applied in several of industries, such as food applications (Cortés-Muñoz *et al.,* 2009) and pharmaceutical cosmetics (Hino *et al.,* 2000 and Elmarzugi *et al.,* 2011). Nanoemulsion is named according to its droplet sizes that ranging in the nanometers between 20 nm to 200 nm (Ee *et al.,* 2008 and Solans *et al.,* 2005).

Compared to other conventional topical preparation such as emulsions, gels, creams, and ointments, nanoemulsions have high solubilization capacity which allows incorporation of large amount of drug. Also it easily modified affinity of drug to the internal phase in nanoemulsion leads to higher permeation rate of drug. Lastly, interaction of nanoemulsion to stratum corneum can improve transdermal drug permeation by changing structural organization of its lipid layers (Azeem *et al.,* 2009). Recently, nanoemulsion hydrogel has been highlighted as one of the most promising drug delivery system by reason of their unique ability in combining hydrogel system with nanoemulsion (Hamidi *et al.,* 2008). Hydrogels are polymeric networks with three dimensional structures which have the ability to absorb a great amount of water or biological fluids (Ferreira *et al.,* 2012). Avocado oil has been used as an antioxidant due to the high amount of oleic monosaturated fatty acids in the oil (Requejo *et al.,* 2003). It also promotes the accumulation of HLD cholesterol that gives health benefits to the cardio vascular system (Logaraj *et al.,* 2008). In addition to that, it is useful as anti-inflammatory agent (Berger *et al.,* 2004) and in cancer prevention (Ding *et al.,* 2007). This study aimed to prepare nanoemulsion hydrogel containing avocado oil for topical application on the skin.

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## MATERIALS AND METHODS

Avocado oil (Sigma-Aldich, South Africa), Sucrose Stearate, glycerol and Carbopol 934, 940 were used in the formulation of nano-emulsion hydrogel by nanophase gel emulsification technique. Ternary phase diagram was constructed using Avocado oil, Sucrose Stearate and glycerol to prepare the nanoemulsion. The glycerol was heated to 75 °C after that the surfactant was added to the hot glycerol until it was dissolved then the oil was added to the surfactant mixture at the same temperature and mixed until the mixture cool down to the room temperature. The nanoemulsion formulations were tested for their droplets size, polydisperspility index (PDI) and zeta potential using zetasizer. Then the Optimum formulation of nanoemulsion obtained from the ternary phase diagram shown in Figure 1 was converted to hydrogels using two different types of Carbopol 934 and 940. The nanoemulsion hydrogels were prepared by mixing different amounts of the optimum nanoemulsion formulations having different concentrations of Avocado oil (10, 20 and 30% w/w) with 0.5% w/w Carbopol and water. The rheological characteristics were performed for nanoemulsion hydrogels.

## RESULTS AND DISCUSSION

Figure shows ternary phase diagrams for three different combinations of oil, surfactant and glycerin. Ternary phase diagrams were constructed to find the optimum composition of oil, surfactant and glycerin that can produce nanophase gel. It can be seen from the ternary phase diagrams, different areas that correspond to different emulsions, such as transparent nanoemulsion (NE), microemulsion (ME), and coarse emulsion (CE).

The ternary phase diagram constructed and presented in fig 1, was used to aid in finding the concentration range of nano-emulsions components (Solans *et al.*, 2005). Sucrose laurate has good emulsification property, which may be due to its excellent miscibility between components in the system. Szuts and Szabo-Revesz; Leong *et al.*, found that nanoemulsion that used high HLB value like sucrose laurate as surfactant has better emulsification properties.

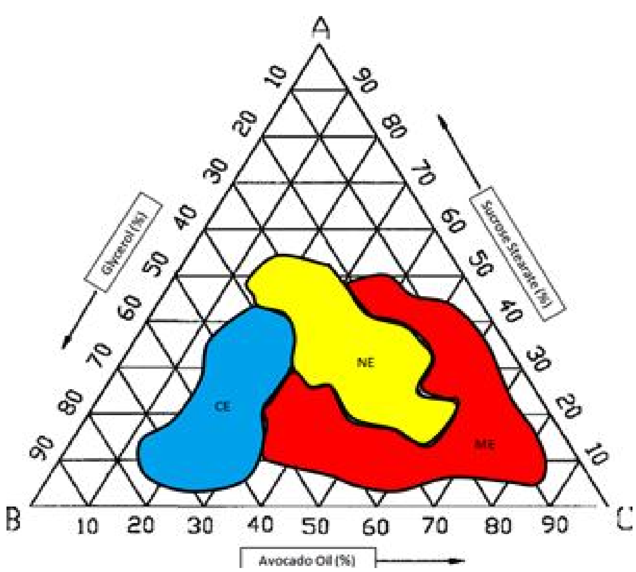


**Fig. 1:** Ternary phase diagram, for Avocado oil, Sucrose Stearate and glycerin.

Table 1, shows the selected formulations from the ternary phase diagram which have droplets size below 200 nm. Among them formulation A consisted of 16% w/w Sucrose Stearate, 24% w/w glycerol and 60% w/w oil has the lowest amount of surfactant and smallest droplets size 105 ± 0.6 nm with PDI 0.113 ± 0.018 and the zeta potential was -31.2 mV. Therefore, it was selected as an optimum formulation to be used in the preparation of nanoemulsion hydrogels because of its lowest droplet size and high stability indicated by zeta potential (Leong *et al.*, 2009 and Kim *et al.*, 2012).

**Table. 1:** Droplets size, PDI and Zeta potential for the nanoemulsion.

| Formulation | Sucrose Stearate (%) | Glycerol (%) | Avocado Oil (%) | Droplet Size (nm) | PDI | ZP (mV) |
|---|---|---|---|---|---|---|
| A | 16 | 24 | 60 | 105 | 0.127 | -31.2 |
| B | 30 | 20 | 50 | 138 | 0.161 | -27.6 |
| C | 20 | 30 | 50 | 147 | 0.157 | -26.9 |
| D | 33 | 33 | 34 | 112 | 0.163 | -28.7 |
| E | 45 | 35 | 30 | 128 | 0.182 | -29.1 |

While table 2, shows the oil droplets size, PDI and zeta potenial for nanoemulsion hydrogel. The droplets were in the range of 114 ± 1.7 to 165 ± 1.1 nm, while the PDI from 0.146 ± 0.011 to 0.190 ± 0.016 and zeta potential from -31.0 to -37.9 mV. It shows that the oil droplets size remain below 200 nm, also PDI was less than 0.2 and low zeta potential < -30.

**Table. 2:** Droplet size PDI and Zeta potential for the nanoemulsion hydrogel (formulation 1, 2 and 3 for Carbopol 934 while 4, 5 and 6 for Carbopol 940).

| Formulation | Carbopol (%) | Avocado Oil (%) | Water (q.s) | Droplet Size (nm) | PDI | ZP (mV) |
|---|---|---|---|---|---|---|
| 1 | 0.5 | 10 | q.s | 125 | 0.185 | -32.2 |
| 2 | 0.5 | 20 | q.s | 127 | 0.180 | -32.9 |
| 3 | 0.5 | 30 | q.s | 135 | 0.150 | -36.6 |
| 4 | 0.5 | 10 | q.s | 114 | 0.146 | -37.7 |
| 5 | 0.5 | 20 | q.s | 144 | 0.157 | -37.9 |
| 6 | 0.5 | 30 | q.s | 130 | 0.190 | -31.0 |

From the results in table 3 it is evident that the values of storage modulus (G’) which describes the elasticity are higher than those of the loss modulus (G”) which reveals the viscosity of the component. It indicates that the formulations are more elastic. In addition increasing the concentration of the oil leads to a relevant increase in the elasticity. Also Carbopol 940 showed an increase in the elasticity compared with those containing Carbopol 934. The application of nanoemulsion hydrogels on the skin is favored by the elasticity of the dosage form (Lippacher *et al.*, 2001).

**Table. 3:** Storage Modulus (G’) and Loss Modulus (G”) for nanoemulsion hydrogel.

| Formulation | Loss /Storage Modulus (Pa) | Angular Frequency (1/s) | | | |
|---|---|---|---|---|---|
| | Share Rate | 0.1 | 1 | 10 | 100 |
| 1 | G’ | 882 | 928 | 980 | 963 |
| | G” | 64.4 | 35 | 48.1 | 96.1 |
| 2 | G’ | 1180 | 1280 | 1340 | 1340 |
| | G” | 155 | 46.5 | 57.2 | 110 |
| 3 | G’ | 1680 | 1840 | 1940 | 1990 |
| | G” | 164 | 70.6 | 83.5 | 150 |
| 4 | G’ | 132 | 162 | 193 | 144 |
| | G” | 22 | 17.4 | 33.3 | 74.5 |
| 5 | G’ | 182 | 231 | 270 | 246 |
| | G” | 33 | 21.6 | 39.1 | 79.3 |
| 6 | G’ | 557 | 661 | 735 | 762 |
| | G” | 83.5 | 45.1 | 70.2 | 14.3 |

## CONCLUSION

In the current investigation, nanoemulsions containing Avocado oil, sucrose Stearate and glycerine were prepared and in-vitro evaluated. Following optimization, nanoemulsion formulation containing 60% w/w oil, 16% w/w Stearate and 24% w/w glycerol was selected. The droplets size, size distribution and zeta potential were studied for the formulation. After achieving nanoemulsion, it was mixed with Carbopol and water to produce nanoemulsion hydrogel. The droplets size of nanoemulsions hydrogel were less than 200 nm with PDI below 0.2 and Low negative zeta potential > -30, which indicate that the formulations are stable. Finally, the elasticity tests of the nanoemulsions hydrogel showed an increase with the increase in oil concentration and the inclusion of Carbopol.

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